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GEOLOGIC AND MINERAL AND WATER RESOURCES INVESTIGATIONS IN WESTERN COLORADO, USING SKYLAB EREP DATA

Monthly Progress Report

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EREP Investigation 380

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INTRODUCTION

The primary objective of the CSM Skylab Program is to analyze EREP data for geologic information. To this end, the research has been subdivided into the following tasks;

Task I. The PI shall assist NASA/MSC in mission planning activities related to the proposed investigation.

Task II. The investigator will screen all EREP data obtained over Colorado and will select frames for detailed study.

Task III. The investigator will prepare photogeologic maps using selected S-190 photographs, and will analyze them to determine what geologic information may be contained in them.

Task IV. The geological interpretations obtained in Task 3 will be compared to interpretations obtained from S-192 imagery, and to interpretations made from ERTS-I imagery.

Task V. The geological interpretations will be verified by means of interpretation of aerial photographs, published geological reports, and field observations.

Task VI. The investigator will prepare recommendations for the optimum type, scale, and resolution of imagery to be used for studies of regional geology and exploration for mineral deposits and water resources.

PROGRESS

Overall Status

With this report, Milestones 1 through 13 have been achieved, with the exception of Milestone 10. Milestone 10 has been voided in favor of a more detailed interim technical report to complete Milestone 19.

Past Month's Activities

Compilation of the geologic map of the Bonanza Test Site has been completed, with the exception of minor areas that will be added as source maps become available. Copies of the map have been reproduced and are currently being proofed.

Low sun-angle photography from one of two flights on NASA mission 261 was received and is being screened. Substantial portions of the Canon City area and South Park are cloud covered, but the remainder is cloud-free and good quality.

A substantial portion of February was spent in the preparation of papers to be presented at 3rd Annual Remote Sensing of Earth Resources Conference at the University of Tennessee Space Institute in late March. The papers to be presented are:

(1) New Uses of Shadow Enhancement by D.L. Sawatzky and Keenan Lee

(2) Geologic Information From Satellite Images by Keenan Lee, D.H. Knepper, and D.L. Sawatzky.

These papers will be published in the proceedings of the conference.

Computer analysis and comparison of ground-measured fractures and lineaments derived from aircraft, ERTS and Skylab data continued.

The semi-quantitative evaluation of the capability of a photogeologist to discriminate different rock types, using

aircraft, ERTS and Skylab photos and imagery continued. Data collection was completed for aircraft photography and ERTS imagery and initial statistical analyses procedures were outlined.

Positive negative masking by slipping the negative in a vertical, horizontal, or diagonal direction can enhance linear features. Intuitively, features that trend 90° to the slip direction are greatly enhanced because the dark of the negative lies directly against the light of the positive, and vice versa. Surprisingly, features are also enhanced that trend from approximately 20° to 90° from the slip direction. Comparison of photo-linears from a slip positive-negative mask and an original positive shows that some significant linears may be found using slip masking, but many are obscured because of the blurring that accompanies slipping. The attendent blurring also makes any identification of features very difficult using the slip masking. The above conclusions result from observing four directions of slip (horizontal, vertical, and two diagonal) on frames 106 and 107, S190A, roll 23 (red band), S.L. 3, and on frame 18, S190A, roll 17 (red band, S.L. 2.

In comparing Skylab photos to geologic maps it is apparent that stereo analysis of S190B color photos allows (1) interpretation of topography, (2) separation of clouds from light-colored rock, (3) discrimination of linear features approximately 100 feet wide, and (4) identification of features with an area less than 1 square mile). Monoscopic viewing gives poor geomorphic expression. S190A photography lacks the detail of S190B photography for lithologic and/or vegetation discrimination.

In a detailed review of the geology of the Leadville and Cripple Creek districts by means of S190B photos taken in August and September 1973, several things became readily apparent. Lithologic discrimination is impossible unless there is a substantial area (several square miles) of exposed rocks of

different colors. This occurred only above timberline in the two areas studied. Along the crest of the Mosquito Range, just north of Weston Pass, Early Cretaceous-Tertiary intrusive rocks appear very light-gray and are surrounded by light to dark red-brown Precambrian granites and Early Paleozoic sedimentary rocks. East-dipping strata on the east side of the Mosquito Range can be clearly seen, but it is impossible to assign lithologies to the Tertiary intrusive rocks or Precambrian granites. Varying amounts of structural detail was also observed in this area. The Weston Fault is clearly seen as an abrupt topographic and vegetation change. The intersection of the Mosquito and London Faults is also seen, although more subtly, because of a change in vegetation caused by contrasting rock types along the fault. Permian-Pennsylvanian sedimentary rocks are grass-covered, Precambrian granites are tree-covered, and where the sedimentary rocks and intrusive rocks are in close proximity, there are both grass and trees. This relationship is further complicated in other areas because of the affects of slope orientation on vegetation growth. Obvious color anomalies in the Leadville district include: (1) the tailings west of Carbonate Hill, (2) the alteration at the Sweet Home Mine (Buckskin Gulch, west of Alma), and (3) the red beds of the Maroon Formation near Ruedi Reservoir.

In the Cripple Creek district, the only areas above timberline are around Pikes Peak. The rocks here appear yellow-orange to red-orange on the photography, and consist of Precambrian granites. There color is due to the large amount of pink microcline in the granite. Other areas with light vegetation cover just northeast of Cañon City, are underlain by arkosic sedimentary rocks which appear brilliant red on the photos. Within the vegetation-covered areas, all exposed rocks and soils appear to have a reddish tinge, again because of the microcline in the granite outcrops and soils. A few lighter areas correspond to nearly white granites. Most light areas on

the photo are mine dumps or tailings ponds (especially obvious just east of Cripple Creek and just south of Victor). Vegetation corresponds to lithology in a gross way; the flatter areas tend to be Precambrian granite and are grass-covered (appear light green), while the steeper hills are usually underlain by Miocene volcanic breccias and intermediate extrusive rocks, and are pine-covered (appear darker on photography). This too is very dependent on slope direction, and vegetation alone is not reliable as a lithologic indicator. Structure, mainly fracture patterns in the granites, are very obvious because they have been enhanced by erosion. Color anomalies in the Cripple Creek district are areas of light or dark-colored rock, since the entire region has a generally red-orange coloration.

Observations on color-additive viewing were carried out using S.L. 3, track 48, S190A, frames 106 and 107, taken in August, 1973. Film chips used were the positive and negative transparencies of the two photo-infrared bands and the red and green bands, and the positives of the color and color-infrared bands. The photo-infrared bands give essentially the same information (ie.- they distinguish water bodies and cloud shadows). The positive of the red band gives the same information as the color band, but color gives more subtle changes in hue when white light is projected through it (eg.- it is the only band that distinguishes cloud from light-colored rocks). Color-infrared distinguishes vegetation types (eg.- verdent from stressed, lowland from highland) and indicates soil moisture and topography. The green band shows essentially the same information as the red band, but not as sharply. The best combination found to enhance red features (presumably color anomalies associated with mineralization) is the color positive with white light at an intensity of 9 on an I^2S viewer (on a scale of 1 to 9), the positive of the color-infrared band on blue at 7, and the negative of the red band on white at 9. The red features appear red, clouds are white, and all else is

light blue to gray. However, some problems that are encountered are a lack of stereo viewing capability and a degradation of image quality. It would be most helpful to have a band that mutually distinguishes cloud from snow from light rock. Perhaps such a band is available in the S192 multispectral scanner imagery or perhaps this discrimination could be made by manipulating the S192 data.

Planned Activities for Current Month

Computer analysis of fracture data and the comparison and correlation of these data with lineament data from aircraft, ERTS and Skylab data will continue.

Studies on the slip masking enhancement technique, the comparison of geologic information content of Skylab photography and geologic maps, and the applications of color additive viewing will also continue, and an evaluation of Skylab photography for regional geologic interpretations will begin.

The two previously mentioned papers will be presented at the 3rd Annual Remote Sensing of Earth Resources conference at the University of Tennessee will be presented.

Supplemental data requests will be submitted for specific types of Skylab/EREP data over our test site. The requests will be for:

(1) 3.7 X positive transparencies of selected S190B frames
(2) selected bands and combinations of bands of S192 imagery in a format suitable for photointerpretation.

Travel

There was no travel during February.

Travel to the 3rd Annual Remote Sensing of Earth Resources Conference at the University of Tennessee and field checks

in the Leadville and Cripple Creek areas are anticipated for March.

Outlook and Recommendations

With the receipt of S.L. 3 data, research is proceeding along a productive course towards meeting of the project objectives.

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